Title: Women's Underrepresentation in Academic Physics in the People's Republic of China

ABSTRACT

Despite recent scholarly focus on women's underrepresentation in the sciences, little is known about gender disparity in science outside the US and Europe. Since much growth in global science is occurring outside these geographic areas, especially in East Asia, this omission represents a significant gap in the literature. Here we rely on 40 in-depth interviews with both male and female physicists—a discipline of science where there is extensive gender segregation—conducted among physicists in Chinese universities. We ask how Chinese physicists explain why there are few women in physics. Analysis reveals that Chinese social and cultural contexts are reflected in physicists' interpretations of gender segregation. Specifically, the cultural and economic transition in China provides physicists with two competing national gender narratives: gender equality and women's subordination. Both national gender narratives exert influence on Chinese physicists' explanations for gender disparity in physics. Findings further indicate that male and female physicists in China share similar gender beliefs, and their beliefs further translate to discriminatory behaviors towards female physicists throughout their career trajectory. This study asserts a new scholarly discussion about women's underrepresentation in science within China and has implications for gender segregation in elite occupations more broadly. Findings also provide implications for public policies to reduce gender stratification in Chinese science.

Word Count: 210

This is the author's manuscript, as accepted for publication. Please cite as:

Di, D., Ecklund, E. H., & Lewis, S. W. (2016). Women's Underrepresentation in Academic Physics in the People's Republic of China. *Journal of Women and Minorities in Science and Engineering*, 22(4). <https://doi.org/10.1615/JWomenMinorScienEng.2016015719>

1. INTRODUCTION

Occupational gender segregation—the lack of female representation in certain disciplines—has long attracted scholarly interest (e.g. Becker 1964; Blackburn et al. 2002; Delphy 1977; 1984; Hakim 1991; Hartman 1976; Mincer and Polacheck 1974). Scholars acknowledge that occupational gender segregation both contributes to gendered wage gaps (Peterson and Morgan 1995) and signifies male domination and female subordination (Reskin 1993). Discrepancy in gender is especially pronounced in STEM (science, technology, engineering, mathematics) fields (White and Ivie 2013; Yoder 2011). While women and men in the US, for example, currently earn a nearly equal proportion of bachelor's degrees in science, a “persistence gap” exists with many fewer women pursuing a graduate degree in science and many fewer still advancing to faculty positions (England et al. 2007; Fiorenzine and Cole 1992; Xie and Shauman 2003).

In order to reduce gender disparity in STEM, researchers have identified a number of ways in which gender disparity is reinforced, such as gender beliefs (author citation; Cech 2013), departmental climate (August and Waltman 2004; Hughes 2012; Riffle et al. 2013; Ryabov and Wang 2011), disciplinary cultures (Cech et al. 2011), and cultural norms (Blair-Loy 2003; Hays 1996). Most scholarship that examines the disparity of gender distribution in STEM, however, is confined to Western countries, even though science itself is global.

Gender inequality in Eastern contexts is still understudied with only a few important exceptions that analyze gender stratification in democratic societies (e.g. Brinton 1988; Lee,

Tufits, and Alwin 2010; Verma 2010). Here we analyze Chinese physicists' gender beliefs to better understand how they frame this stratification. Descriptively, we ask how Chinese physicists respond to the lack of women in academic physics. Specifically, how do they explain this gender imbalance? Interpretively, we analyze the extent to which social and cultural contexts in China play a distinct role in physicists' gender beliefs, if at all. We hope this research will have implications for global policies that could reduce gender discrepancies in the sciences among diverse national political, economic and cultural contexts.

We focus on physicists for specific reasons. Among all scientific disciplines, physics is one of the most gender imbalanced (author citation). In the US, only 14 percent of physics faculty members are women (Ivie et al. 2013). Despite the rapidly developing scientific infrastructure in China (Zhou and Leydesdorff 2006), little attention has been paid to gender stratification in Chinese science. While we did not find recent official and nationally representative data about the portion of women physicists in Mainland China, it is telling that less than 10 percent of physics majors at Chinese universities are women (J. Yang 2002). Breaking down the proportion of women in academic physics in China according to their career stages, another study illustrates that less than 20 percent of physics undergraduates in PRC universities are women (Wu 2002).¹ When we get to the professor level, the percent of women in physics further decreases to less than 10 percent (Wu 2002). Considering the fast growing infrastructure and the imbalanced gender distribution in Chinese science broadly, a more comprehensive understanding of gender beliefs among Chinese physicists, in particular, is

needed.

Our findings indicate that Chinese physicists, both male and female, have two salient gender beliefs—gender essentialist notions and beliefs in traditional gender roles—that comprise their active and dominant gender schema of women’s subordination. This gender schema may be further translated into gendered behaviors of discrimination towards women in physics. Through an implicit comparison with literature about gender segregation in the Western context (e.g. Baron-Cohen 2003; Cech 2013; author citation; Reskin 1993), these findings demonstrate that some of the gender beliefs, such as gender essentialism and cultural beliefs about traditional gender roles held among Chinese physicists, are similar to those held by scientists in a Western context. The cultural and economic transition in China, however, provides a unique context in which Chinese physicists frame their understanding of women’s underrepresentation in academic physics. Theoretically, this study contributes to extant gender theories by demonstrating how two competing national narratives co-influence individuals’ gender schemas, how individuals negotiate between these two national gender narratives, and how Chinese people use Confucian gender notions in China to justify their beliefs in traditional gender roles and eventually reinforce women’s subordination in physics. Our findings also have implications for future policies in that we provide initial evidence to understand why gender stratification is reproduced (and hence how to combat it) in the Chinese physics community.

2. LITERATURE REVIEW

2.1 Women’s Underrepresentation in Science

Scholars examine ways in which gender imbalance is reinforced in science. At an individual level, Fiorentine and Cole (1992) believe that women's personalities may contribute to their low representation in demanding fields, arguing that women may be more likely than men to avoid risks and are thus less persistent in pursuing career success (Fiorentine and Cole 1992). Rothblum (1988) also points out that women's psychological characteristics may partly explain their attrition from the academy, with women attaching more value to the approval of others. Such psychological factors are not isolated: women's reliance on others' approval places them in a disadvantaged position once they are discriminated against in the workplace.

Gender essentialism also serves as an important gender belief that may reinforce gender segregation (author citation). Gender essentialism refers to the notion that men are inherently better than women at certain skills, such as systematic thinking (Baron-Cohen 2003). Usually, gender essentialists believe that men's advantage is positioned according to biological gender differences, and thus, cannot be changed (Baron-Cohen 2003). Interestingly, scholars find that though some US scientists subtly attribute male superiority in physics to "morphological differences and biological differences," few scientists regard innate biological differences as the only factor that contributes to gender segregation (author citation).

Those who emphasize contextual factors mainly discuss how organizational forms (Smith-Doerr 2004), departmental climates (August and Waltman 2004; Ryabov and Wang 2011; Verma 2010) and disciplinary culture (Cech et al. 2011) are related to women's underrepresentation in science. Departmental climates may play a role, meaning that women in

departments that are not friendly to them may be more likely to leave their particular discipline (August and Waltman 2004). The notion of the “ideal worker”—a typically masculine image that relies on a forceful personality type—also exists in science; faculty members in scientific disciplines may be expected to be ideal scientists who center their lives on scientific research (Acker 1999; Cech and Blair-Loy 2004; author citation). Under this masculine disciplinary culture that highly values characteristics like assertiveness and being emotionally distant, women are less likely to remain in the so-called “masculine” STEM disciplines (Cech et al. 2011; author citation).

In addition to personal and contextual characteristics, the cultural norm of traditional gender roles serves as another mechanism that perpetuates occupational gender segregation. This norm assumes that men are breadwinners and women are caretakers (Parsons and Bales 1955). Consequently, women professionals experience more pressure than their male counterparts because they perceive the need to strike a balance between work and family (Blair-Loy 2003; Hays 1996; Keene and Quadagno 2004; Moore, Meiksis, and Root 2013; Shauman and Xie 1996; Thompson and Bunders 2001). Constrained by the cultural norms of traditional gender roles, women may choose more mother-friendly occupations to carry out family responsibilities (Okamoto and England 1999). And some of those women who stay in science sacrifice their family responsibilities and have fewer children than they would like (author citation). Though there is extensive research that displays the mechanisms, which reinforce gender segregation in the West, we do not know to what extent these mechanisms also contribute to the discrepancy in

China.

2.2. Mechanisms That Reinforce Gender Stratification in China

Mainland China is experiencing two closely related and simultaneous transitions: the economic transition from State-oriented planning to a market economy and the cultural transition from the Mao era to the post-socialist era (Oi 1995; Fan 2003; Robinson 1995). These two transitions, which occurred in the same period, leave profound implications for gender relations in China. The cultural transition that loosens ideological control from the central government contributes to the revival of traditional masculine culture and discriminatory gender beliefs (Fan 2003). Specifically, the Confucian interpretation of women's receptiveness to and dependence on husbands was revived in the cultural transition and has become an important gender belief that discourages women from entering the workplace in general (Y. Chen 2008; Goldstone 1996; C. Li 2000; H.Li and L.Chen 2012). Most scholars see Confucian gender notions as a deep-rooted national gender narrative in Chinese society that subordinates women (Blake 1994; Fan 2003; Gao 2003; Goldstone 1996; C. Li 2000).² Empirical study supports the connection between traditional cultural norms and occupational gender segregation, arguing that "serious gender discrimination in Chinese tradition" is a significant factor that reinforces occupational segregation in China (Meng and Miller 2005:151).

With respect to the economic transition, the semi-free market system provides room to further transform this national gender narrative of women's subordination to discriminatory actions. The market-based economy, for example, gives companies more power in the hiring

process (Shu 2004), and most companies are reluctant to pay for medical insurance for pregnant women (Xia 2001; Zhao and Liang 2005). Women are thus discriminated against in the hiring process, dismissed when companies are restructured within this economic transitional period, and eventually segregated into low-status and low-paying occupations (Shu 2004; Xia 2001).

Gender stratification not only exists in the broader Chinese society but also persists in STEM. In 2007, the Chinese Academy of Sciences produced a descriptive report to examine factors that lead to the underrepresentation of female scientists in the PRC (Chinese Academy of Sciences 2007). The report found that less than six percent of STEM academicians are women (Chinese Academy of Sciences 2007). According to this report, three mechanisms operate together to contribute to gender segregation in STEM: over-performance, direct exclusion, and the imposition of traditional gender roles (Chinese Academia of Sciences 2007).

Initial studies about gender relations in the PRC provide us with a rough picture of the salience of women's underrepresentation in Chinese sciences and how this underrepresentation is produced and reproduced. On the one hand, similar to what happens in Western countries, females are discriminated against in Mainland China (e.g. Xia 2001). On the other hand, scholars contend that Chinese traditional culture and the transitional period are socially specific mechanisms that perpetuate gender stratification in the PRC (e.g. Fan 2003). While some scholars are starting to discuss gender segregation in broader Chinese society and in specific the lack of female representation in science (e.g. Chinese Academy of Sciences 2007; Shu 2004; Xia 2001; Zhao and Liang 2005), scholars have paid less attention to academic scientists' own

interpretations about the lack of women in physics, a necessary piece of understanding gender disparity in Chinese science. Based on studies in Western contexts (e.g. author citation; Cech 2013) and initial studies in China (e.g. Fan 2003; H.Li and L.Chen 2012), we argue that an investigation of Chinese male physicists' gender schema provides an important lens to understand how gender stratification is reinforced in academic physics in the PRC.

2.3. Gender Narratives and Gender Schemas in China

Schemas in general are the rules of social life or “techniques or generalizable procedures applied in the enactment/reproduction of social practices” (Giddens 1984:21; Sewell 1992). A gender schema, in particular, refers to the cultural models about gender categories and people's default assumptions about the relative dominance and subordination between men and women (Cech 2013; DiMaggio 1997). A gender schema might be composed of multiple gender beliefs, such as beliefs about gender categorization, gender roles, and gender essentialism (Cech 2013; Ridgeway and Correll 2004). And a gender schema can easily shape people's gender behaviors, influence the distribution of resources, and reinforce the gender structure (Cech 2013; Ridgeway and Correll 2004; Sewall 1992).

Our understanding about Chinese physicists' gender schema should be viewed against the backdrop of national gender narratives in the PRC, which changed dramatically during the social transformation (Riskin, Zhao, and Li 2001). In Mao's era, governmental narratives about absolute gender equality reveal China's ideological dedication to becoming an egalitarian country (Fan 2003; Riskin et al. 2001; Zang 2008). To frame gender relations in terms of

absolute gender equality, the Chinese government has widely publicized that women have exactly the same abilities as men (Robinson 1995; Zang 2008). Guided by this understanding of gender equality, in the 1950s, the Chinese government assigned female students to major in physics even though these students did not apply to be physics majors (J. Yang 2002). This governmental ideology of absolute gender equality was widely accepted before the social transformation occurred (Zang 2008).

Within this social transformation, however, the government loosened its sanctions on gender equality and created sufficient room for the revival of Confucian interpretations of women's subordination (Fan 2003; Riskin et al. 2001). When women were discharged and discriminated against in the job market during the economic transition era (Zhang 2014), most Chinese people were confronted with the tension between the national narrative of absolute gender equality and the reality of women's subordination in the job market (Zang 2008). The transition from the government exerting absolute gender equality to a revival of traditional gender beliefs produced two opposite and competing national gender narratives: the narrative of absolute gender equality and the narrative of women's subordination. At the individual level, these two national narratives may both exert influence over Chinese people's gender schemas. Our analysis of Chinese physicists' perceptions of gender disparity in academic physics in the PRC discloses both physicists' gender schema and the profound implications from their gender schema.

3. DATA AND METHODS

The data for this article were taken from a large cross-national comparative study. The broader study consists of in-depth interviews with physicists who work at universities in the United States, the United Kingdom, and the People's Republic of China (PRC). Here we focus on gender stratification in China, where we specifically asked scientists how they understand the low proportion of women in physics when compared to other scientific disciplines (we did not ask this question of scientists in the two other national cases). We did this to obtain deep descriptions of how Chinese physicists understand the lack of women in physics. A close analysis of gender stratification in the PRC scientific community and a theoretical comparison with literature about gender disparity in the West will facilitate comparative studies among different national contexts in the future.

The findings of this paper are based on interviews with 40 physicists in the PRC, conducted in three major cities that differ in political climate, economic development, and geographic location: Beijing, Shanghai, and Xi'an. Shanghai is one of the most market-oriented and economically developed cities in the PRC, and Beijing is the capital city. Xi'an, located in Middle-Western China, is less economically developed and market-oriented and yet is a major hub for the development of strategic industries. It is also home to many excellent universities. Conducting interviews in these three cities allows us to understand scientists' perceptions about gender discrepancy in both coastal cities with market-oriented, globalized economies, such as Shanghai, and more traditional planned-economy cities in the interior, such as Xi'an. The educational backgrounds of scientists who participated shed light on the differing degrees of

openness and development in these three cities. Following Project 985, a massive Chinese government project to build world-famous universities (L.Li 2004), we differentiated elite universities and non-elite universities in the PRC.

Among the eighteen scientists we spoke with in Shanghai, six obtained their doctoral degrees overseas and all have a Ph.D. In Beijing, four out of ten scientists we spoke with obtained their Ph.D. outside of China. Two participants in Beijing claimed that they did not have a Ph.D., yet were nonetheless employed as professors in Chinese universities. Among the twelve scientists we interviewed in Xi'an, only two obtained their Ph.D. overseas and three did not have a Ph.D.

Within these three cities, we selected only universities that grant doctoral degrees in physics. We randomly chose individual respondents from faculty lists on the official website of each university. To recruit participants, we sent hard-copy invitation letters by international express mail and follow-up interview invitations by e-mail and phone. Thirty-four interviews were conducted in person and six interviews were conducted by phone. The interviews lasted from 30 minutes to two hours with an average length of one hour. Respondent age ranged from 33 to 67 years old. Thirty-five respondents were men and five respondents were women. The overrepresentation of male physicists in our sample is, to some extent, indicative of the overrepresentation of male scientists in physics more broadly. Many Chinese physicists that we interviewed spoke some English but most felt more comfortable participating in Chinese. We conducted thirty-seven interviews in Mandarin Chinese, with the remaining three interviews

conducted in English.

One of the paper authors conducted a majority of these interviews. Both male and female researchers were in the interview settings of most face-to-face interviews, with a male researcher conducting the interviews and a female researcher (in some cases together with another male researcher) transcribing the interview as it occurred. Half of the phone interviews were conducted by a male researcher and another half of the phone interviews were conducted by a female researcher. The presence of both male and female researchers in most face-to-face interviews helps us to understand how respondents may interact with both males and females in their daily lives in a better and somewhat more accurate way. Furthermore, regarding the phone interviews, when analyzing the data, we did not find that male physicists refrain from expressing their gender beliefs, and specifically their schema of women's subordination, when the interviewer was female. We speculate that having no differences between interviews that were conducted by the male and female researcher may illustrate that Chinese physicists' gender schema is an overarching schema that is not context sensitive.

In-person and phone interviews were not recorded and were instead transcribed in real time by another co-author. We refrained from audio recording because of Chinese social norms and professional concerns about privacy. After transcribing, one co-author of the study as well as native Chinese-speaking students translated all interviews. One co-author is bilingual in English and Mandarin, and another is trilingual in English, Mandarin, and Shanghainese. We adopted a three-round editing process to ensure the translated interviews capture physicists' perceptions of

gender discrepancy through their narratives. We primarily analyzed responses to the following question: “There are so few women physicists. In your opinion, what factors caused this phenomenon?” Considering the nature of our qualitative research approach (Strauss and Corbin 1998), we report our findings according to the salient themes that we detected in data analysis. When presenting our findings, we chose the more representative quotes to illustrate our participants’ narratives. To indicate a broader picture of our data, we also point out the number of respondents who share similar narratives with the quoted participants. Enabled and constrained by the qualitative research process, this research cannot (nor does it aim to) capture narratives that are representative of all Chinese academic physicists. Rather, it displays how some Chinese physicists interpret the lack of women in academic physics, charting a course forward for other research on this important topic.

4. FINDINGS

4.1. Chinese Physicists’ Gender Beliefs: Gender Essentialism

Among the forty physicists that we spoke with, nine participants,³ both men and women, attribute men’s overrepresentation in academic physics to native gender characteristics. They think that men are inherently better than women when it comes to creativity, systematic thinking, and conducting innovative scientific work. Such a gender-essentialist perspective is represented in our conversation with a male professor⁴ at a non-elite university in Xi’an. When we asked him why there are so few women in physics, he said:

A simple fact is that there have been only a few women scientists who

have won the Nobel Prize, such as Curie and several others. Most Nobel Prize winners are men scientists. I think, biologically, men and women are different. Biologically and statistically speaking, most prizewinners are men. Probably, biologically speaking, men are better in conducting scientific research. This includes how men's brains process information.

This is unchangeable.

This professor's point of view exemplifies male Chinese physicists' gender essentialist notions that attribute men's overrepresentation in academic physics to a perceived biological advantage in systematic thinking when compared to women.

Another male full professor⁵ at an elite university in Xi'an also adopted a similar gender essentialist explanation to legitimize men's overrepresentation in physics. When we asked him whether he thought women physicists experience more pressure than their male counterparts, he laughed and said, "What kinds of stress do they have?" He then spent several seconds thinking about this problem carefully and attributed gender segregation to biological differences. He commented:

It may be a result of in-born biological difference of males and females.

It's the same case in our department; there are few women professors. It is mostly male. I think men and women approach problems with quite different ways of thinking.

Similar to the previous respondent, this professor also thinks that the overrepresentation of men

in his department is due to the biological differences between men and women regarding systematic thinking. This physicists' explanation is a typical representation of male Chinese physicists' gender essentialist beliefs.

This gender essentialist belief is predominant yet not exclusive to male physicists. When explaining the overrepresentation of men in physics, a female professor⁶ at an elite university in Shanghai said:

Perhaps physics requires a lot of mathematics skills. I remember that physics requires a lot of mathematics when I was an undergraduate student. Also, theoretical physics needs a lot of logical thinking.

Using high requirements for mathematic skills and logical thinking in physics to explain this gender discrepancy, this female professor implicitly holds the assumption that males are inherently better than females at mathematical skills and logical thinking which, according to her, explains why there are more males than females in physics. This female professor's gender essentialist belief is very similar to that of her male colleagues.

Physicists' essentialist beliefs are prevalent in the academic community in the PRC. Narratives such as "It may be a result of biological differences of males and females,"⁷ "I think the logic of thinking of men and women are different,"⁸ "broadly speaking, males have advantages in scientific thoughts and innovations,"⁹ "female physicists' ability to explore new things is not as good as their male counterparts,"¹⁰ and "they (females) do have the temporary ability to explore new things but most of them do not have the sustainable ability"¹¹ consistently

appeared throughout our interviews with Chinese physicists. Demographically, some of these gender essentialist physicists are relatively young professors who have been trained in industrial countries outside China,¹² while others are senior professors who obtained their degrees in Chinese universities.¹³ Chinese male physicists' gender essentialist notions seem to be a commonly held gender belief across diverse demographic characteristics. Regardless of their educational background, academic titles, elite status of their universities, and even their gender identities, physicists that we spoke with use their gender essentialist beliefs to explain and justify females' low representation in academic physics.

4.2. Chinese Physicists' Gender Beliefs: Traditional Gender Roles

In our conversations with Chinese physicists, most of them (23 out of 40), both men and women, acknowledged the notion of traditional gender roles that require women to assume more family responsibilities and for men to be the breadwinners. Yet, different from their counterparts in the West, Chinese physicists explicitly articulated the traditional gender role as part of the traditional culture. The explanation provided by a male associate professor¹⁴ at a non-elite university in Shanghai displays how Chinese physicists use traditional cultures to legitimize women's responsibilities within families. He said:

According to our Chinese traditional culture, it seems that female and male scientists have the same working pressure. If there are differences, these differences come from their different pressures from the family...Maybe the Chinese traditional culture requires female scientists

to focus more on families. As a result, she could not entirely focus on social problems.

When this male associate professor expressed his belief in traditional gender roles, he situated it within the Chinese traditional culture.

Another male full professor¹⁵ at a non-elite university in Shanghai also attributed gender segregation to traditional gender roles and justified these roles using Chinese and “oriental” cultures. When he answered the question about the lack of females in physics, he stated:

Women scientists have to overcome more difficulties. It is not easy for them. Especially in China and other oriental countries, we have different expectations regarding social responsibilities for men and women. Women have to carry more social responsibility regarding families and education. Males in China, males in oriental countries, they should be more professional. They should make greater efforts to reach certain scientific levels. It is more than making efforts. They have more pressure from different places.

Different from the previous professor who described such traditional family arrangements with an emphasis on women, this professor illustrated traditional gender roles by underscoring men’s responsibilities. Yet, very similar to the previous professor, this respondent also uses the notion of traditional gender roles to justify women’s underrepresentation in physics.

It is worth noticing that this cultural belief in traditional gender roles is not unique to male physicists in China. Some of our female physicists also implicitly or explicitly hold this gender belief. A female full professor¹⁶ at an elite university in Shanghai told us:

I think-the difference between males and females in science is about your investment. In China, as a female scientist, you will carry more responsibilities than your male counterparts because of your family and children. For instance, my kid will take the entrance examination to high schools; during this period of time, I have to spend a lot of time to [take care of my daughter]. My husband does not need to take care of these things. If female scientists do not need to take care of her family and can invest all they have (into science), her work can be as excellent as her men counterparts.

She is similar to her male counterparts who also believe in traditional gender roles, emphasizing that this happens “in China;” this female professor frames women’s family responsibilities as distinctively Chinese.

The belief in traditional gender roles assumes that women are not only caretakers in their families but also financially dependent on male breadwinners. When using her belief in traditional gender roles to explain the gender stratification in Chinese physics, another female professor¹⁷ at a non-elite university in Beijing said, “Probably women want to marry rich husbands. My classmates were all like that. I have been educated to be financially independent

since my childhood.” In other words, this female professor believes her parents’ attempt to break the traditional gender roles in her childhood explain why she—as an exception among women—eventually became a physicist. She also notes that this largely held belief in traditional gender roles is a way to explain gender stratification in academic physics in the PRC.

Chinese physicists’ belief in traditional gender roles is an important component of their active and dominant gender schema of women’s subordination. Different from their Western colleagues who may also believe that women are supposed to carry more family responsibilities (author citation), a lot of, although not all, Chinese physicists frame their beliefs in traditional gender roles through the interplay of Chinese traditional culture and their gender beliefs, expressing women’s family responsibilities as something that is supported by “traditional Chinese notions.”¹⁸ And given this distinctively Chinese cultural notion, women scientists are find it “rather hard to do excellent scientific research.”¹⁹ The interplay between Chinese traditional cultures and their gender beliefs displays this Chinese physicists’ individual-level gender schema is partly constructed by the national gender narrative that comes from Confucianism. By situating their traditional gender role beliefs in the Chinese culture, these physicists are implicitly asserting that their beliefs in traditional gender roles can hardly be abandoned given that they are deeply rooted in Chinese traditions. It is important to note that some physicists who use Chinese traditional culture to support their beliefs in traditional gender roles have received extensive exposure to Western gender notions when they were trained in industrial countries outside China.²⁰ They seem to have,

however, the same gender schema with their senior colleagues who have been trained entirely in the PRC.

4.3. Co-Influence from Both National Gender Narratives

In addition to Chinese physicists' reliance on gender essentialism and traditional gender roles to explain the lack of women in physics, another national narrative—that of absolute gender equality (Bauer et al. 1992; Fan 2003; Robinson 1995)—also exerts some impact on Chinese physicists' framing of women's underrepresentation in science. We should acknowledge that the potential impact of the national narrative of gender equality is not as salient as that of women's subordination, and Chinese physicists are able to find ways to negotiate these two national gender narratives and still justify women's subordination in academic physics. This co-influence from both national gender narratives is exemplified in the articulations from seven out of the forty physicists that we talked with.

For example, a male full professor²¹ at a non-elite university in Beijing felt the necessity to claim that gender equality should exist when he talked about gender stratification in science. Yet, he still used his gender essentialist point to justify gender segregation in academic physics. He explains:

Of course, we should advocate that women can-But it is impossible for them to be as competitive as men. Why not? Because you should carry some other social [responsibilities], such as giving birth. When God (*Shang Di*) created you, he gave you this responsibility. If you want to

act in opposition to God (*Shang Di*), it is Ok. But in terms of the result, you are not as good as male physicists. This is the fact.

At the beginning of his description, this professor gave a momentary nod to gender equality to perhaps informs us that he realizes the national narrative of absolute gender equality. Yet, after a short pause, he said that it was impossible to achieve absolute gender equality because men and women are essentially different. This description demonstrates that he is very aware of the national narrative of absolute gender equality, feeling somewhat obligated to claim that “women can (do physics).” But this national narrative has not been internalized by him in his gender schema, meaning that it does not prevent him from expressing his notion of gender essentialism despite this momentary nod to women’s equal ability.

This professor’s schema of women’s subordination further guides the way in which he instructs his female graduate students. In the interview, this professor described how he directed a female graduate student to study “social physics” rather than hard-core physics. He told us that “social physics” is a sub-discipline that adopts physics axioms to understand the development of society. When explaining the reason why he encouraged this female student to study “social physics,” he said:

I recruited a female student this year. She conducts research in social physics. Why? She does not have a solid foundation in physics. It would be difficult for her to conduct complicated research. It is relatively easy to conduct social physics research. We should cultivate students

according to their different abilities and qualities.

Two national narratives about gender—the absolute gender equality and women’s subordination—both appear in this Chinese physicist’s explanation to women’s underrepresentation in physics. Yet, only the narrative of women’s subordination becomes a dominant gender schema that guides his behaviors in daily interactions. As an advisor, this professor’s stereotypical perception about female physics students could influence his students’ self-evaluation and actual performance. Some female physics students in China, thus, may lose their professional confidence due to their interactions with advisors who holds a schema of women’s subordination.

The impact from both national gender narratives is also reflected in the way in which our respondent expressed his beliefs in traditional gender roles and his empathy towards explicit gender discrimination. Reflecting on why his university is reluctant to hire female graduates in physics, a male associate professor,²² who works at a non-elite university in Beijing, showed empathy for this discrimination and attributes it to traditional gender roles. When we asked him about why there are so few women in academic physics, he told us that in theory the Chinese government has enacted policies to encourage female scientists; however, “In application most institutions are still reluctant to accept female students, female PhDs.” He personally agrees with the practice that excludes female PhDs, saying that female PhDs are not as ideal as their male counterparts because of women’s involvement in housekeeping and childrearing. Expressing empathy towards this underground university policy, he said:

Because a female PhD gives people the impression that, say, after she comes she might be more concerned about life. Maybe boys wish to do more scientific research, and advance more in career; perhaps girls enjoy comfort, and would consider childbearing, house ownership, and family – all kinds of life issues... Including the female PhD staying here in our place. How would they do any scientific research, basically what they do every day is – of course household chores are very important. That's why we basically don't consider accepting female students. Of course there are exceptions, for example coming with their spouses. Of course I know many good scientific researchers. I highly respect that. I have always respected female scientists.

At the end of his narratives, this male physicist acknowledged the existence of good female scientists and emphasized that he always respects his female colleagues. His acknowledgement of good female scientists and his respect for them shows the impact that the national narrative of absolute gender equality has on his understanding of gender disparity in academic physics. Yet, the national narrative of women's subordination, particularly the notion of traditional gender roles, is more salient to this male physicist, composing his schema of women's subordination and further leading to his empathy towards the explicit gender discriminatory action that excludes women from the hiring process.

The impact from both national gender narratives—absolute gender equality and women's

subordination—on Chinese physicist’s explanations to the underrepresentation of women in physics consistently appeared among our interviews. But, in most cases, our physics respondents only internalize the gender narrative of women’s subordination as their active and dominant gender schema while the impact from the narrative of absolute gender equality is very limited. Usually, the narrative of absolute gender equality is reflected in Chinese physicists’ uncertainty and hesitance when they were trying to use their gender schema of women’s subordination to interpret the lack of women in physics. For instance, before stating the view that men are more capable in scientific areas, a male scientist²³ admitted, “Maybe I am biased.” Another male scientist²⁴ said, “This is my own feeling. I mean, relatively speaking...” A male full professor commented,²⁵ “It might be my bias, but I think that men have a better understanding in this area.” Even a male physicist²⁶ who asserts that males have advantages in scientific thinking and innovation said, “But it is not definite. Probably men have certain advantages.”

That Chinese physicists were somewhat reticent to express their arguments about women’s subordination may reflect their negotiation of the impact from two distinctive national gender narratives during a cultural transition period. Influenced by the notion of absolute gender equality, the Chinese physicists we spoke with realized that it is politically incorrect to declare that women are less competent than men. Yet, their dominant and active gender schema is still the schema of women’s subordinations. Multiple gender beliefs, such as gender essentialist notions and beliefs in traditional gender roles constitute this gender schema. Chinese physicists in our sample use two ways to negotiate the co-influence from two opposing national gender

narratives. They either express their uncertainty when articulating women's subordination or use personal pronouns to reflect their individual ownership of such gender essentialist and discriminatory narratives. While these two competing gender narratives might be almost equally salient at a societal level, at an individual-level, the effects from the narrative of absolute gender equality is very much latent, and Chinese physicists are still quite comfortable when using the schema of women's subordination to explain the underrepresentation of women in physics.

4.4. Translation to Gender Behaviors: Discrimination Toward Female Physicists

China has transformed from a state-oriented economy to a semi-market-based economy (Oi 1995; Fan 2003; Nee and Matthews 1996; Robinson 1995). After this transition, the government partially lost its control over the economic market. For instance, the Chinese government does not assign graduates to different occupations any more. Instead, it allows people to freely compete with each other in the job market (Oi 1995; Fan 2003; Nee and Matthews 1996; Robinson 1995). This economic transition, thus, provides gatekeepers, most of whom are physicists themselves, with room to practice their gender schema in the form of discriminatory actions in the hiring process, and these discriminatory actions extend to female physicists' entire career trajectory. The description from seven out of the forty respondents, both male and female, exemplifies the potential salience of discriminatory actions in academic physics in China.

A male associate professor²⁷ working at an elite university in Shanghai explicitly attributed the reason for gender segregation in physics to the difficulties women physicists face

in finding jobs. He proclaimed:

The number of female students majoring in physics is increasing. But it is very, very difficult [for them]. It is Ok if they want to teach in universities. However, if they want to find a job after graduation, women will find that companies don't want students majoring in physics and students who are female.

This professor acknowledged that discrimination by companies constrains their opportunities for upward social mobility, and may facilitate women's withdrawal from physics, although there is an increasing number of female physics students at universities.

Given the visibility of women physicists' disadvantages on the job market, a male professor²⁸ explicitly stated, "First of all, gender discrimination still exists in China." By gender discrimination, he was referring to discrimination in the hiring process. He added, "Now, women professors here... In the same condition, an excellent woman probably cannot be hired by the university but a man will be hired by the university." The previous professor suggested that women have equal access to academic positions even though females experience gender discrimination when seeking industrial jobs. This professor realized that women are in a disadvantaged place even when they are looking for an academic job.

To some professors, employment discrimination becomes one of the most salient explanations of gender segregation in physics. A male professor,²⁹ who works in an elite university in Shanghai, did not agree with the gender segregation statement at first. He said, "I

am really surprised [that you asked me this question]. I have not thought about this problem. I have not paid attention to it before.” Saying, “I am really surprised,” this professor implied that gender segregation should not be a major issue in academic physics in China. Yet, after a several-second pause, he acknowledged, “Of course, compared with their male counterparts, it will be more difficult for them to find a job.” For a professor who “[had] not thought about” gender segregation, discrimination in the job market became the first associated factor he thought of. His statement, to some extent, reflects the salience of hiring discrimination against women physicists in China.

After transitioning from a state-oriented economy to a market-based economy, the Chinese government no longer assigns jobs, causing gender discrimination in the job market to become a more prevalent issue (Zhang 2014). Chinese physicists’ narratives further demonstrate that, similar to what happens in other disciplines, female physics graduates are also discriminated against. Given that the government is loosening the controls over absolute gender equality in the job market (Zhang 2014), it is reasonable to assume that most of the gatekeepers might be physicists themselves.

Most of our male respondents, who recognize explicit gender discriminatory behaviors, note that such behaviors usually happen in the hiring process. Our female physicists, however, have a more in-depth reflection on their own experience of being discriminated against. These female physicists inform us that they experience gender discrimination throughout their whole career trajectory. Our conversation with a female associate professor at an elite university in

Xi'an illustrates how female physicists are discriminated against even after they achieve relatively high-status positions and how physicists' gender schemas are translated to their discriminatory behaviors. When this female associate professor was asked about gender stratification in physics, she first said, "I agree with this. Why? After all, in China, there is still discrimination against females." Then, she summarized her disadvantages as a female physicist, saying, "So for female physicists there are two situations. One is that people will not accurately judge your ability because you are a woman. Second, is that for most programs, females are not advantaged in competition." Chinese physicists' schema of women's subordination is converted to people's action of discrimination towards females, which, in this female associate professor's words, is an inaccurate judgment of female physicists' abilities. Even though she has already obtained a position as an associate professor, she is discriminated against not only by her peers but also by her prospective students. She articulated, "When we are hiring students we also have this problem, students are unwilling to come (to the lab) if they find out that the teacher is a female."

Another female associate professor³⁰ at an elite university in Shanghai also told us about her experience of being discriminated against in academia. She said, "When I asked for help setting up some equipment, the person the department sent was not very respectful because I am a woman. He called me *xiao gu niang* (little maiden) instead of professor and did not listen to my suggestions." In Chinese, *xiao gu niang* (little maiden) is usually used by men to imply their distrust of women's abilities. Being called a *xiao gu niang* (little maiden) rather than a professor,

this female scientist believed that she was disrespected because of her gender.

Both male and female physicists in our sample realize gender discrimination exists in the physics community in China. These gender discriminatory behaviors are shaped by underlying gender schemas that may serve to reinforce women's underrepresentation in academic physics in China. Male physicists believe that gender discrimination is the most salient in the hiring process. Having a more nuanced reflection on the salience of gender discrimination in science, their female colleagues realize that gender discrimination towards women may start from the hiring process but extend to their entire career. Female physicists' reflection on gender discrimination in science informs us how physicists' gender schema may change to encompass their gender discriminatory behaviors, and eventually fortify gender stratification in physics.

5. DISCUSSION AND CONCLUSION

We have analyzed Chinese physicists' perceptions regarding gender segregation in the physics community in modern China, a country that is experiencing both cultural and economic transition. Findings demonstrate that the national-level economic and cultural contexts influence individual physicists' perceptions of gender relations. Relying on interviews with Chinese physicists, we found three ways in which gender stratification is reinforced in academic physics in China. First, Chinese physicists' narratives show that they have two predominant gender beliefs: gender essentialist notions and beliefs in traditional gender roles. Holding these two predominant gender beliefs, Chinese physicists prefer the schema of women's subordination. Second, although the national narrative of absolute gender equality and women's subordination

both have an impact on Chinese physicists' explanations of gender segregation in physics, the impact from the narrative of absolute gender equality is latent and limited. In their articulations, Chinese physicists use different approaches, such as giving a momentary nod to women's capability, expressing their uncertainty when talking about their gender beliefs, and using personal pronouns to reflect their individual ownership of such gender beliefs, to negotiate between these two competing and even opposing national gender narratives. They eventually internalize the narrative of women's subordination as their dominant and active gender schema to explain gender disparity in academic physics in the PRC. Finally, as gatekeepers for physics, Chinese physicists' schema of women's subordination is translated into discriminatory behaviors towards female physicists. This explicit gender discrimination is the most obvious in the hiring process, but it exists in female physicists' whole career trajectory.

We may assume that physicists would have different gender beliefs and hence different gender schemas because of their diverse ages, educational backgrounds, elite status of universities, and their experience in the Chinese social transformation. Surprisingly, Chinese physicists' narratives do not differ according to their age, elite status of university, or geographic location of university, which implies that Chinese physicists in general may have overarching gender beliefs that constitute their very similar gender schema. It is particularly important to note that although female physicists may have a more nuanced reflection on their experience of gender discrimination in physics, they share the two predominant gender beliefs with their male counterparts, meaning that they *may* have the same gender schema as their male physics

colleagues. Based on their narratives, we do not perceive female physicists as pioneers who will transform the gendered structure in physics in China. Instead, they may actually be part of reinforcing this gendered structure.

Scholars have examined mechanisms that reinforce gender segregation in democratic and economically developed countries in the Western context, arguing that part of gender segregation in the Western context is explained by people's gender essentialist notions (author citation), culture of individualism (Cech 2013), people's beliefs in traditional gender roles (author citation), and gender discrimination in the hiring process (Reskin 1993). Conducting an implicit comparison with findings about gender beliefs that lead to segregation in the Western context, we argue that Chinese physicists have similar gender beliefs—gender essentialist notions and beliefs in traditional gender roles—as their counterparts in the Western contexts. Yet, there are some particular features of Chinese physicists' expression of gender beliefs. First of all, when Chinese physicists frame their belief in traditional gender roles, they situate it in Chinese cultural traditions. In doing so, Chinese physicists use traditional cultures to legitimize their beliefs in traditional gender roles. The intersection between the belief in traditional gender roles and Chinese culture suggests that part of Chinese physicists' gender schemas come from the national gender narrative of Confucianism. Furthermore, different from their colleagues in the West, the social transformation in China provides Chinese physicists with two competing national gender narratives—the narrative of absolute gender and that of women's subordination. Both narratives exert influence on Chinese physicists' explanation to women's underrepresentation in academic

physics. Yet, only the narrative of women's subordination is internalized by Chinese physicists and become their dominant gender schema. In addition, unlike people in the US (Cech 2013), Chinese physicists do not use self-expression to explain and justify gender segregation in the PRC. Among all 40 physicists we spoke with, *only one* of them³¹ attributes gender segregation in part to women's individual choices and interests. This implicit comparison between the reproduction of gender disparity in the US demonstrates that gender stratification is consistently reproduced in both the US and the PRC. The specific approaches that gender segregation reproduces in the PRC are different from those in the US, however.

Our findings thus make contributions to the existing literature about women in science, demonstrating that people may use traditional cultures to justify and fortify their gender beliefs. In addition, this study also reveals that people have the ability to negotiate between two national gender narratives even though this national gender narrative is opposing one other. Specific to the case in China, and in contrast to the expectation of the Chinese government, the governmental ideology of absolute gender equality does not replace the cultural tradition of women's subordination. We contend that physicists' perceived interaction between traditional Chinese culture and traditional gender roles as well as their negotiation between two national gender narratives explain the inability of the ideology of absolute gender equality to replace the tradition of women's subordination. This theoretical implication is novel and has not been fully developed by schools in either cultural sociology (e.g. DiMaggio 1997; Sewall 1992; Swidler 1986) or sociology of gender (e.g. Cech and Blair-Loy 2014). Beyond the context of the PRC,

our theoretical argument about people's justification of gender beliefs and their negotiation between two national gender narratives may be applicable to understanding gender beliefs and the reproduction of gender stratification in both Eastern and Western contexts.

Additional studies would need to take into account the limitations of this study. One limitation is the overrepresentation of male professors in our sample. In this article, we heavily rely on the narratives provided by male physicists even though we successfully recruited five female respondents. Our initial analysis demonstrates that the female physicists that we spoke with share similar gender essentialist notions and beliefs in traditional gender roles with their male colleagues. Although the number of female physicists in our sample is fairly small, this study is an explorative study to understand how Chinese physicists as a whole—both male and female—may contribute to reinforcing women's underrepresentation in science. Building on the empirical foundation of our study, to obtain a more complete picture of Chinese physicists' perceptions on gender segregation in physics, future studies should attempt to analyze narratives of female Chinese physicists. Scholars can also interview Chinese women who withdraw from physics in order to understand their perceptions of being a former physicist in the scientific community in China.

The transition period in the PRC seems to provide physicists with competing gender schemas. Their ability to negotiate between these competing gender narratives, unfortunately, makes the schema of women's subordination their dominant schema. Physicists' schema of women's subordination may have real consequence in female physicists' performances through

interactions even in well-intentioned mentoring programs (Dunham et al. 2014; Ridgeway and Cornell 2004). Following Dunham et al. (2014), we also suggest that universities in the PRC should enact better-designed programs to encourage healthy interactions between male scientists and their female colleagues to mitigate the potential negative consequences from interactions that are guided by biased gender beliefs.

With the increasing interaction between scientists in China and their colleagues in other industrial societies, we may expect that scientists, as a group of people who have received intensive exposure from developed and westernized societies, will become pioneers in transforming the gendered structure that are rooted in Chinese Confucianism. Our analysis displays, however, that physicists who have received training outside the PRC share similar gender schemas, comprised of the same gender beliefs as their colleagues who are trained in China. That means we cannot await Chinese physicists' increasingly intensive exposure to Western scientific training to automatically resolve gender stratification in Chinese science. Moreover, given that most of our female participants have similar gender beliefs and gender schema as their male counterparts, we do not expect that Chinese female physicists will hold progressive gender schemas and transform the gendered structure. In that case, more explicit interventions should be introduced to increase women's status and their representation in academic physics. We believe that restraints on gender discrimination can be the starting place to mitigate gender stratification in Chinese physicists and other STEM areas in general. If there are policies that can curb this visible discrimination and encourage employers to hire more female

scientists, more women might be willing to enter and stay in physics.

NOTES

¹ The only exception is the portion of women in physics department in normal universities (Wu 2002). Undergraduates in normal universities are most likely to be physics teachers in K-12 education. We speculate that the comparatively high percentage of female physics undergraduates in normal universities is related to the cultural meanings attached with being teachers in K-12 education.

² We also note that a few scholars (e.g. Jiang 2009) perceive Confucius gender notions as a resource that may *potentially* improve women's status in contemporary China.

³ Some participants may combine multiple gender beliefs in their narratives, meaning that the number of respondents who hold each specific gender belief may outnumber forty (the total number of respondents).

⁴ CHINA31, professor, male, conducted 12/27/13.

⁵ CHINA32, professor, male, conducted 12/27/13.

⁶ CHINA02, professor, female, conducted 08/01/13.

⁷ CHINA32, professor, male, conducted 12/27/13.

⁸ CHINA32, professor, male, conducted 12/27/13.

⁹ CHINA 33, professor, male, conducted 01/23/14.

¹⁰ CHINA17, professor, male, conducted 08/16/13.

¹¹ CHINA17, professor, male, conducted 08/16/13.

¹² See CHINA 31, professor, male, conducted 12/27/13 as an example. See CHINA02, professor, female, conducted 08/01/13 as an additional example.

¹³ See CHINA 17, professor, male, conducted 08/16/13 as an example.

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- ¹⁴ CHINA07, professor, male, conducted 08/05/13.
- ¹⁵ CHINA08, professor, male, conducted 08/05/13.
- ¹⁶ CHINA02, professor, female, conducted 08/01/13
- ¹⁷ CHINA24, professor, female, conducted 12/20/13
- ¹⁸ CHINA25, professor, male, conducted 12/23/13; CHINA31, professor, male, conducted 12/27/13.
- ¹⁹ CHINA25, professor, male, conducted 12/23/13.
- ²⁰ See CHINA08, professor, male, conducted 08/05/13 as an example.
- ²¹ CHINA17, professor, male, conducted 08/16/13.
- ²² CHINA23, associate professor, male, conducted 12/20/13.
- ²³ CHINA22, lecturer, male, conducted 12/19/13.
- ²⁴ CHINA17, professor, male, conducted 08/16/13.
- ²⁵ CHINA32, professor, male, conducted 12/27/13.
- ²⁶ CHINA 33, professor, male, conducted 01/23/14.
- ²⁷ CHINA03, professor, male, conducted 08/02/13.
- ²⁸ CHINA25, professor, male, conducted 12/23/13.
- ²⁹ CHINA03, professor, male, conducted 08/01/13.
- ³⁰ CHINA 39, associate professor, female, conducted 11/22/12.
- ³¹ CHINA 33, professor, male, conducted 01/23/14.

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